Future Missions at GSFC

November 1998

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Future Missions at GSFC

- Potential New Missions
  - Medium Explorers (MIDEX)
  - Small Explorers (SMEX)
  - Earth System Science Pathfinder (ESSP)
  - New Millennium
  - Triana
  - Earth Observing System Missions
  - Gamma-ray Large Area Space Telescope (GLAST)
  - Next Generation Space Telescope (NGST)
  - High Throughput X-ray Spectroscopy (HTXS)
  - Magnetospheric Multi-scale
  - Global Electrodynamics
  - Magnetosphere Constellation
- Technology Requirements

Future Missions at GSFC

Changes from 1997

- Dropped Solar Stereo
  - to be implemented by APL
- Added Triana
- Changed EOS ALT to Icesat
- Added DS5

Future Missions at GSFC

Changing Environment of Future Work

- Ground system and operations support may or may not involve GSFC
  - PIs may do some or all of these functions
  - Industry may provide these services
  - CSOC may provide these services
- Many missions looking for advanced technology development to lower implementation costs
- Mix of large and small missions
  - Largest is ~ $500 million for mission development
  - Smallest is ~$40 million for mission development
- Spacecraft missions are only one class of opportunity
  - Non-spacecraft missions - instruments, balloons
  - Non-traditional work
  - Software support for other centers - tools, simulators

Future Missions at GSFC

MIDEX

- IMAGE - Imager for Magnetopause to Auroral Global Explorer
  - Launch January 2000
  - ASSIST based ground system
  - Simple operations
- Microwave Anisotropy Probe (MAP)
  - Launch mid-2000
  - In-house spacecraft
  - Ground system common with IMAGE
  - L2 orbit
  - Simple operations
- Subsequent MIDEX missions
  - Approximately 1 per year - next one launches 2002
  - $140 million total lifecycle cost cap
  - Need to compete for future missions
  - Selection of next two missions December 1998

Future Missions at GSFC

Small Explorers (SMEX)

- HESSI selected for launch in 2000
  - Solar flare mission
  - Ground system and operations at University of California at Berkeley
  - Reusing ITOS for operations and spacecraft I&T
- GALEX selected for launch in 2001
  - Ultraviolet Imaging and spectroscopic survey of galaxy evolution
  - Spacecraft operations by Orbital
  - Science ops mostly at California Institute of Technology
- Future SMEX missions capped at $71 million total life cycle costs
- Future missions are PI missions
- Next AO expected in spring 1999

Future Missions at GSFC

New Millennium

- Technology driven missions
- JPL has several deep space missions in this program
- GSFC has New Millennium-Earth Observing 1
  - Advanced technology Landsat instrument
  - MIDEX-like spacecraft
  - Launch 12/99
- NM EO-2 - MSFC shuttle Lidar Demonstration (Sparcle)
- NM EO-3 - currently soliciting science measurement concepts
- NM DS-5 - low earth orbiting mission managed by GSFC
  - Launch 2003
  - Several candidate missions under evaluation
    - nanosat constellations
    - solar sails
    - tethers
- Future EO New Millennium missions expected every 1.5 years

Future Missions at GSFC

Earth System Science Pathfinder (ESSP)

- $120 M total cap - spacecraft, instrument , launcher, ground system, ops
  - First one (2000)- $60 M - Vegetation Canopy LIDAR
  - Second one (2001) - $90 M - GRACE (JPL)
- Next two missions to be selected in December 1998
- Approximately one per year
- PI mode missions
- Probable missions:
  - Polar or high inclination orbit
  - Low or moderate data rates (5 - 500 kbps)
  - Ground station communication
  - Common I&T and ops system
  - No simulator
  - Ground system located at PI site

Future Missions at GSFC

Triana

- Science/education mission
- Near real time image of sunlit earth from L1
  - Updated every 15 minutes
  - Data widely distributed to schools
- Launch goal - July 2000
- SMEX-lite spacecraft
- $75 million
- Goal of 5 years of operations

Future Missions at GSFC

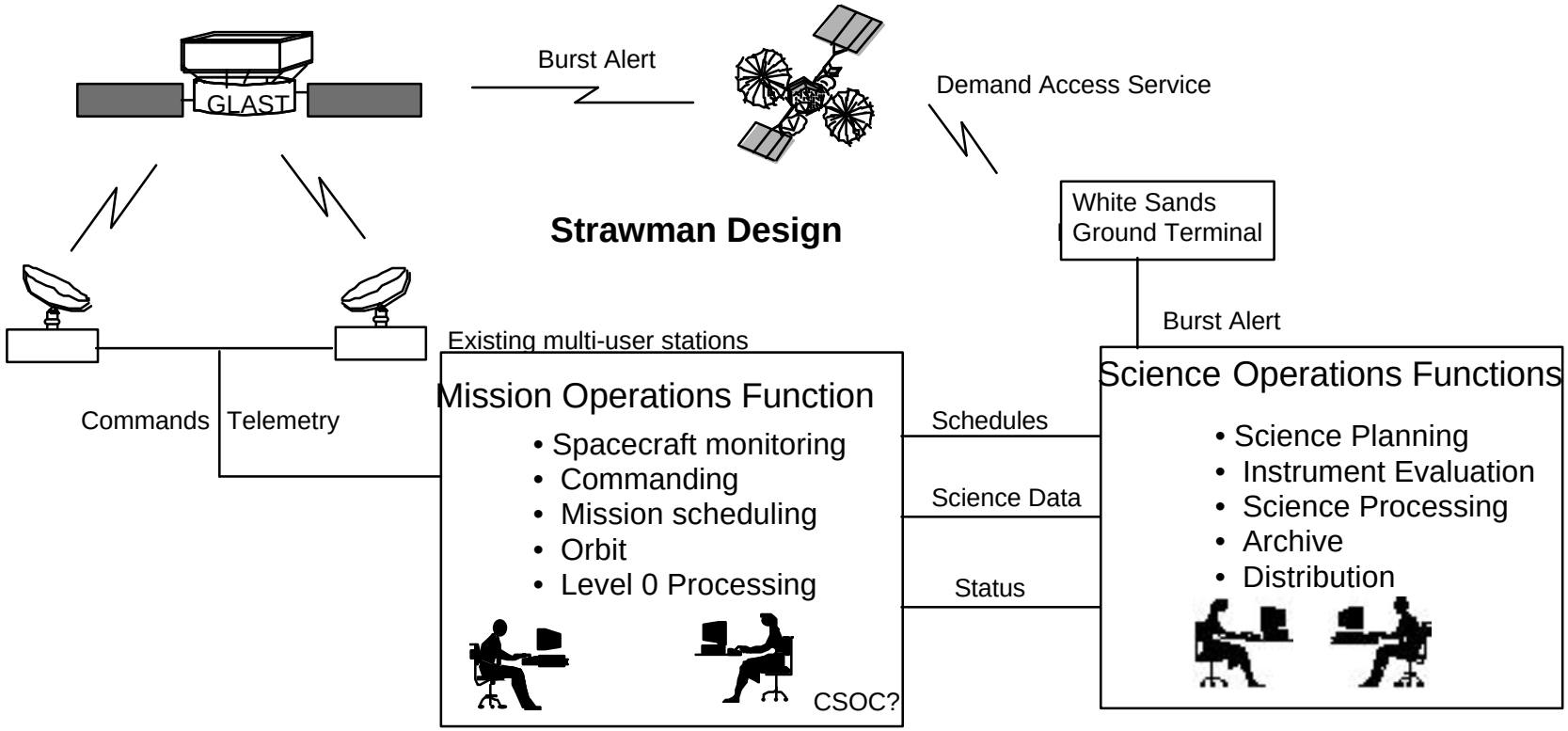
Earth Observing System (EOS)

- Supported by EDOS and ECS
- ECS responsible for MOC and operations through 10/2002
  - EOS-AM 1 Launch mid 1999
  - EOS-PM 1 Launch December 2000
- EOS-Chem - 12/2002
  - spacecraft common with PM-1 spacecraft
- Icesat - 7/2001
  - Smaller, moderate rate mission
- Post 2002 missions currently being defined

Systems Integration and Engineering Branch	Future Missions at GSFC
CODE 581	Gamma-ray Large Area Space Telescope

Gamma-ray Large Area Space Telescope (GLAST)

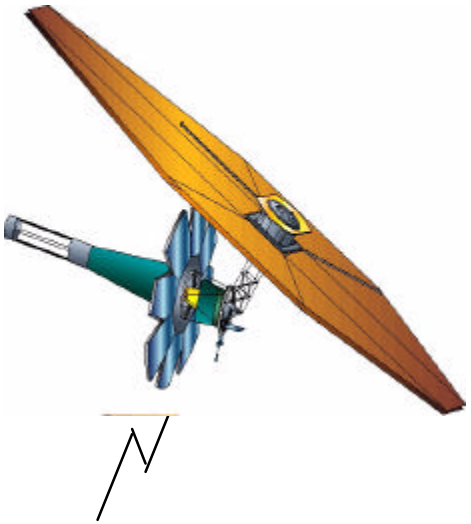
- Studies active galactic nuclei, pulsars, black holes, gamma ray bursts, ...
- Launch 2004
- 550 km orbit. 28.7° inclination
- Rapid communication required for gamma-ray burst alerts
- ~330 kbps average data rate
- Tight time correlation requirements (microseconds)
- ~ $300 M



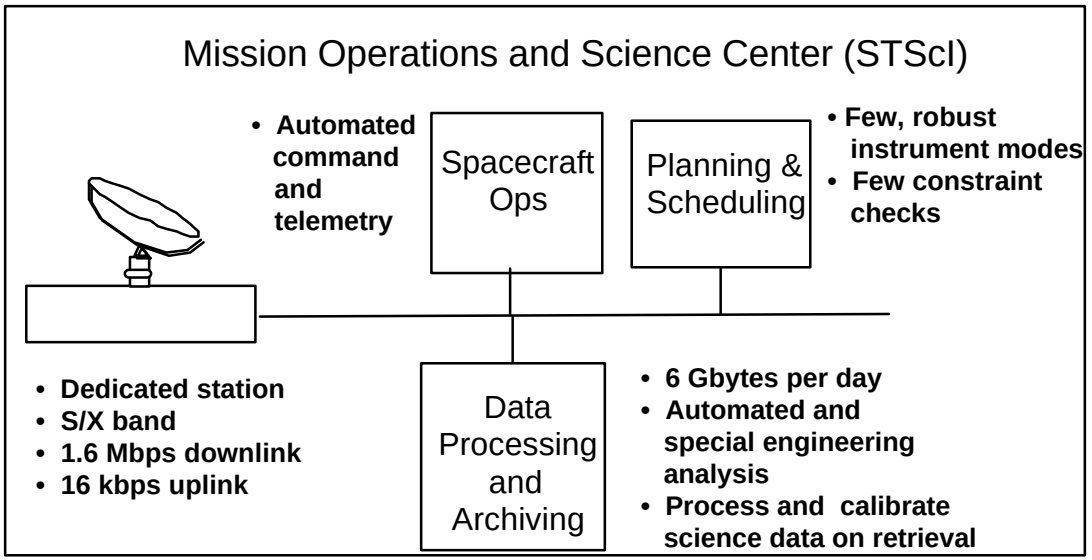
Systems Integration and Engineering Branch	Future Missions at GSFC
CODE 581	Next Generation Space Telescope (NGST)

Flight S/W

- **Common software components, standards**
- **File to file transfers of loads, observation data**
- **Simple, robust safemode**
- **Onboard autonomy**
  - **attitude**
  - **guide star selection**
  - **activity sequencing**
  - **momentum management**
  - **antenna pointing**
  - **telemetry filtering**



- Infrared imagers to explore galaxy formation
- Launch 2008
- 8 meter deployed mirror
- Inflatable sun shield
- L2 orbit
- Dedicated ground station
- Combined science and mission ops
- 500 kbps average rate
- ~$500 Million development cost
- 10 year lifetime

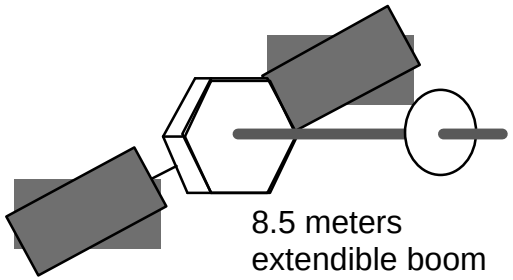


- **All functions colocated**
  - **reduced comm costs**
  - **cross-trained ops**
  - **common data bases**
  - **single cmd generator**
  - **single archive**
  - **no contention for station**

Future Missions at GSFC

Constellation-X

- 100x increase in sensitivity for X-ray observations
- Launch around 2008
- 6 identical spacecraft/instruments
- L2 orbit
- 1 DSN contact per day
- 200 kbps average rate
- ~$600 million



Future Missions at GSFC

Magnetosphere Multiscale

- Magnetosphere Multiscale
  - 4 identical spacecraft in tight formation
  - 2 other identical spacecraft in loose formation with each other
    - 1.2 by 10 Re, low inclination
  - Formation has several phases that include lunar swingby
    - Phase 1: 1.2 X 12 Re, low inclination
    - Phase 2: 1.2 x 30 Re, low inclination
    - Phase 3: 8 x 235 Re, variable inclination
    - Phase 4: 10 x 50 Re, 90° inclination
  - Spacecraft separation varies from 10 km to 10 Re
  - Several Gbits per spacecraft per day
  - Interspacecraft communication/ranging possible
  - Launch 2005
  - ~$120 M
  - Ops overlap with other sun-earth connection missions
    - Possible common information system

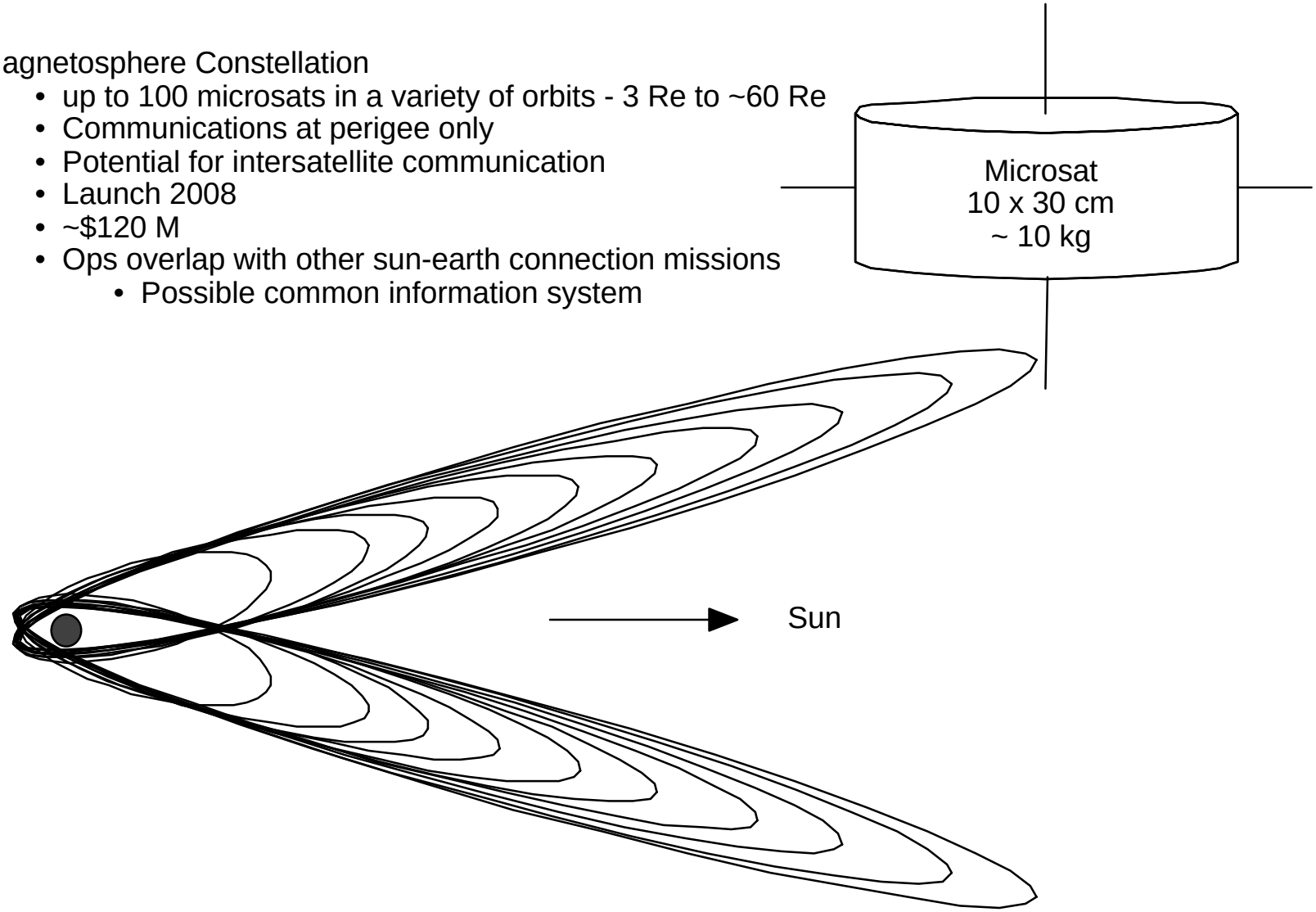
Future Missions at GSFC

Global Electrodynamics

- Global Electrodynamics
  - 4 spacecraft in polar orbit
    - 3 in identical orbit, one one hour different
  - Dip below 150 km once per day
  - Launch 2007
  - 1 Gbit per spacecraft per day
  - 8 instruments
  - ~$120 M
  - Ops overlap with other sun-earth connection missions
    - Possible common information system

Systems Integration and Engineering Branch	Future Missions at GSFC Magnetosphere Constellation	S F G C
CODE 581		

- Magnetosphere Constellation
  - up to 100 microsats in a variety of orbits - 3 Re to ~60 Re
  - Communications at perigee only
  - Potential for intersatellite communication
  - Launch 2008
  - ~$120 M
  - Ops overlap with other sun-earth connection missions
    - Possible common information system



Future Missions at GSFC

Missions under Study

- Space Science Missions for late in the next decade
  - ARISE - VLBI radio astronomy mission, 25 m radio telescope
    - Under study by JPL
    - Data rates of ~8 Gbps
  - LISA - Gravity wave mission
    - Under study by JPL
    - 3 spacecraft, interspacecraft ranging
  - OWL - Study highest energy particles
    - 2 spacecraft
    - GSFC study
- Advanced technology geosynchronous earth observing missions

Future Missions at GSFC

Technology Needs

- Most of the larger missions intend to make significant investments in technology to lower development and operations costs
- Other sources of funding available for technology for the lower cost missions
- Technology needs:
  - Formation flying
  - Operations of large number of similar or identical spacecraft
  - Testing of large number of similar or identical spacecraft
  - Autonomous operation
  - Rapid, on demand data communication
  - Low cost systems
  - Flexible, evolutionary science information systems
  - Standards-based space/ground communication
  - Lower cost flight software approaches
  - Higher bandwidth uplinks
  - Tools to reduce costs to support science users
  - Interspacecraft communication

GODDARD SPACE FLIGHT CENTER

APPVL RESP _____

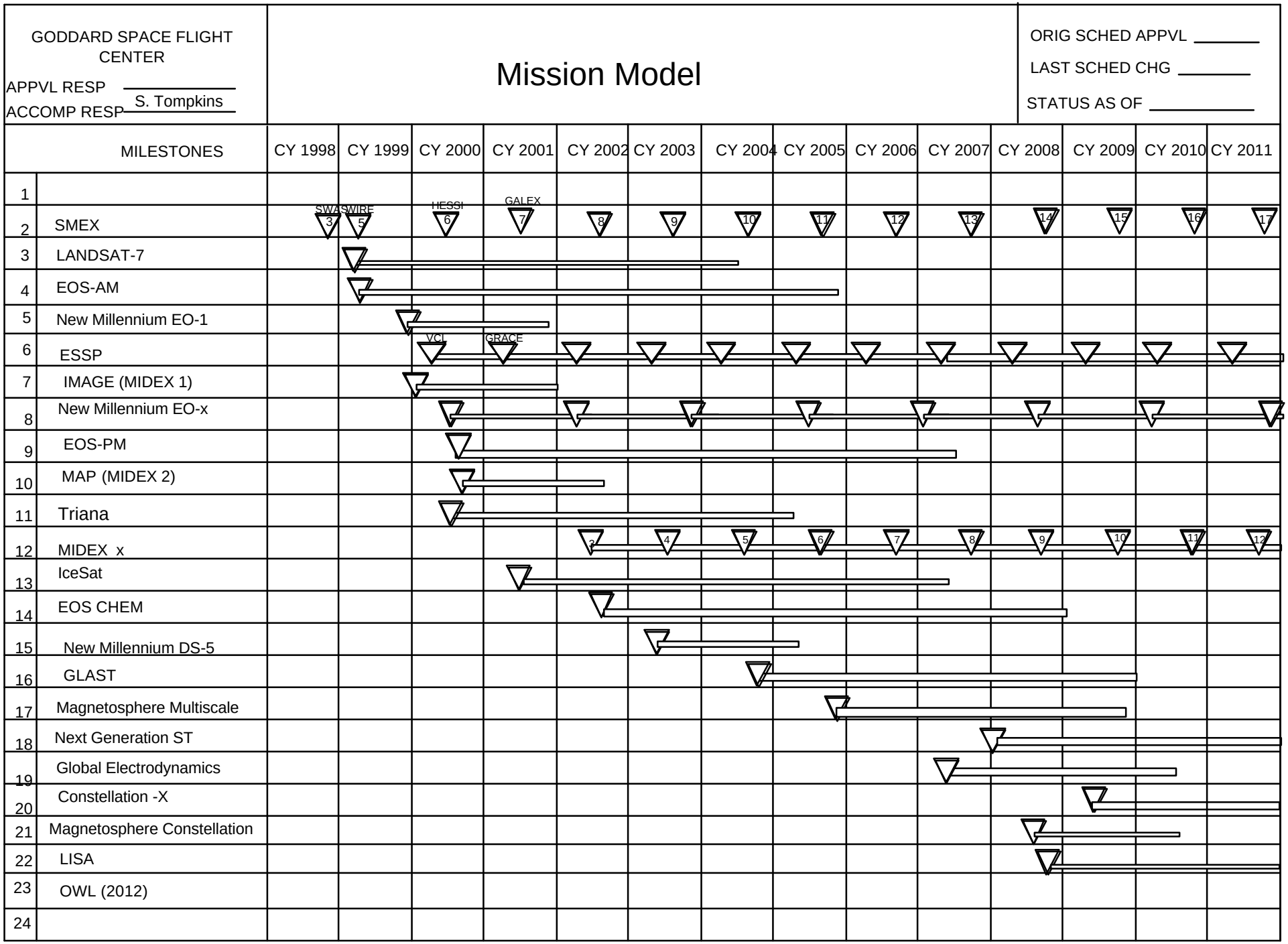
ACCOMP RESP S. Tompkins

Mission Model

ORIG SCHED APPVL _____

LAST SCHED CHG _____

STATUS AS OF _____



Future Missions at GSFC

For More Information

- GLAST - http://www-glast.stanford.edu/
- NGST - http://ngst.gsfc.nasa.gov/
- Constellation X - http://constellation.gsfc.nasa.gov/
- Sun-earth connection missions - http://umbra.nascom.nasa.gov/spd/secr/
- LISA - http://lisa.jpl.nasa.gov/
- OWL - http://lheawww.gsfc.nasa.gov/docs/gamcosray/hecr/owl_new.html
- ARISE - http://www.nrao.edu/~julvesta/ARISE.html